

# **Report for 2004NC42B: Integration of High Resolution Imagery in Cost-effective Assessment of Land Use Practices Influencing Erosion and Sediment Yield**

There are no reported publications resulting from this project.

Report Follows

## Title

### Integration of High Resolution Imagery in Cost-effective Assessment of Land Use Practices Influencing Erosion and Sediment Yield (70207)

## Problem and Research Objectives

National concerns have increasingly focused on the degradation of this nation's water quality and associated resources. As the Nation's population increases, so does society's ability to continuously alter the landscape leading to amplified surface loadings from storm and watershed overflow, increased suspended sediments in runoff, and agricultural and industrial drainage problems. Monitoring land use has become critically important as best management controls must now directly contend with the need for additional agricultural, industrial and urban growth and the desire to protect water quality.

Improving degraded watersheds and streams require accurate and current land use and land cover (LU/LC) data. The Center for Earth Observation's previous study showed that, state-of-the-art, IKONOS imagery provides an effective means of obtaining LU/LC data within an urban watershed. IKONOS is particularly effective at delineating impervious surfaces prevalent in urban areas. However, IKONOS classifications based on single date imagery have some limitations with regard to other LU/LC classes. The delineation of bare and disturbed soils proved problematic. Bare and disturbed soils are a small part of the total proportion of the area within a watershed but these areas play a critical role in water quality and sediment load. Bare and disturbed soils are nearly identical spectrally and are often misclassified with fallow agriculture. Additionally, grass and open space which are commonly a significant part of an urban/suburban watershed, are often confused with agriculture. Due to the seasonal nature of agriculture, using multi-date imagery could be effective in distinguishing agriculture from the grass/open space class and from the bare/disturbed soil class.

Quantifying accurate LU/LC change within a watershed is an important component of monitoring watershed quality. During our previous study, IKONOS proved to be an effective means to quantify land use composition within an urban watershed. However, our initial analysis of LU/LC only provided a snapshot of the watershed land use composition at a single point in time. To completely understand the impact land use has on water quality, it is also important to accurately assess the type and position of changes occurring within the watershed. This can be accomplished through change detection using remotely sensed imagery. Currently, most LU/LC change detection studies have used lower resolution imagery. However, lower resolution imagery may be incapable of accurately detecting small-scale or mixed LU/LC classes that fall below the resolution of the imagery but still may be significant contributors of upland sediment load.

The objectives of this research were to evaluate the effectiveness of mapping detailed urban LU/LC categories which have the greatest potential for influencing the water quality by taking full advantage of high-resolution Quickbird imagery through the utilization of: (1) data fusion techniques, (2) supervised and unsupervised classification, and (3) post-processing filters. "Treatments" within each of the objective were to be

assessed so as to isolate variables of interest for each objective. Results were to be evaluated in terms of final land use and land cover map as compared with the GPS-assisted reference data collected in the field for determining accuracy.

## Methodology

The study area, originally the Hominy Creek watershed, North Carolina, was revised, with WRRI approval, to include highly active and continuously changing watersheds in Northeast Raleigh, North Carolina. The level and scale of change occurring in the North Raleigh area would provide greater indications of the water quality, impervious surface areas, high-growth indices, and their linkages produced through the techniques being developed for this study. The North Raleigh study area contains primarily urban and suburban land uses interspersed with large forested clusters. The study area totals 71.5 km<sup>2</sup> and is located just northeast of the capital city of Raleigh, and has been sited as one of the areas of highest growth from 2000 to 2004.

The general approach for this study consisted of four steps: (1) pre-processing of the data; (2) evaluation of different data fusion, classification and post processing techniques; (3) final classification procedure based on the results from evaluation process; and (4) accuracy assessment. The pre-processing step involved accurate geometric registration of the images, atmospheric corrections, etc. The evaluation process consisted of applying the three different data processing tools (data fusion, classification method, and post processing filter) to assess their effect on the classified maps. Any differences in map accuracy should be largely explained by the effect of these tools. Consequently, the third step was the determination of the final classification procedure based on the input from the evaluation process. In the final step, accuracy assessment of the final thematic map was performed.

It is important to distinguish the terms “classification method” and “classification procedure”. Classification method describes the choice of a specific algorithm to assign raw image values to pre-determined land use/land cover (LU/LC) types. On the other hand, classification procedure is a much broader term involving pre-processing of the images, selection of the classification algorithm, post-processing, and the accuracy assessment.

## Principal Findings

Six distinct LU/LC categories having the greatest impact on water quality were determined from our classification analysis; Deciduous Trees, Evergreen Trees, Herbaceous Vegetation, Bare/Disturbed Soil, Water, Impervious. Image classification performed using a supervised classification procedure and a 3x3 majority filter algorithm, yielding an overall classification accuracy of 80.29% (Kappa 0.73). The users' accuracy for the impervious surface category was 94% (Kappa 0.89). The results suggest the classification accuracy and level of detail produced from high-resolution imagery, using the procedures detailed in this study, can be used to accurately identify and quantify levels of LU/LC which influence water quality within highly urbanized watersheds, particularly impervious surfaces.

## Significance

The development of a historic dataset, in which to base current and future changes, may then be used to estimate projected rates of LU/LC change and rates of land use stability in the watershed. These calculations may then be used to model sediment source contributions as a result of land use type variations within the watershed.